Trichoderma (teleomorph Hypocrea) is a well-studied fungal genus that currently consists of more than 200 molecularly defined species. Members of this genus are found in a wide range of climatic zones and in many ecosystems, but the most common and natural habitat of these fungi is known to be soil. *Trichoderma* species are frequently found parasitizing other fungi, on dead wood and bark, in soil and rhizosphere, associated to woody and herbaceous plants and as endophytes. Some strains have the ability to reduce the severity of plant diseases by inhibiting plant pathogens, mainly in the soil or on plant roots, through their high antagonistic potential. However, *Trichoderma* rhizosphere-competent strains have been shown to have direct effects on plants, increasing their growth potential and nutrient uptake, fertilizer use efficiency, percentage and rate of seed germination, and stimulation of plant defences against biotic and abiotic damage. In recent years, an increasing number of studies have contributed to unravelling the molecular basis of the plant–Trichoderma dialogue and the beneficial effects of *Trichoderma* to plants. Nevertheless, there are insufficient biological data to fully understand species-specific plant response to inoculation with various *Trichoderma* species/strains. Moreover, the available literature and the conclusions from our preliminary studies have shown that it is necessary to develop a deeper understanding of the interaction between wheat plants and *Trichoderm*a species/strains exhibiting different lifestyles. Beneficial effects of *Trichoderma* have been reported in terms of wheat growth and yield and enhanced resistance to biotic stresses. However, to the best of our knowledge, no comprehensive framework for the entire phenotypic reaction of wheat to *Trichoderma* spp. has yet been published.

Therefore, the main goal of the research project is to understand the molecular basis of wheat responses to *Trichoderma* spp. root colonization. The proposed study will be conducted to investigate changes in the morphology, anatomy, physiology as well as proteome, transcriptome and metabolome of wheat plans induced by a root colonization, by two *Trichoderma* species, with particular emphasis on identifying unique and specific changes depending on the fungal strain. To examine the wheat responses to *Trichoderma* inoculation of roots, two bread wheat cultivars and two *Trichoderma* strains will be applied into the research. *Trichoderma* strains that will be used in the proposed studies originated from Poland and are deposited in the collection of the Institute of Plant Genetics, Polish Academy of Science, Poznań, Poland.

To access the effects of *Trichoderma* strains on morphology, anatomy, and physiology of wheat plants, growth component, yield parameters, chlorophyll fluorescence, and gas exchange parameters of wheat plants under laboratory and field conditions will be measured as well as microscopic observations of anatomical changes in roots and leaves of wheat plants will be performed. Identification of protein differentially accumulated in roots and leaves of wheat seedlings between the treated with *Trichoderma* and untreated plants will be performed by advanced electrophoresis and mass spectrometry analysis. The amino-acid sequences of identified and selected proteins will be used for the identification of the genes differentially expressed in roots and leaves of wheat seedlings treated and untreated plants. To analyze changes in the metabolome of wheat seedlings during interaction with *Trichoderma* strains, high throughput and sensitive analytical methods will be used. All data will be integrated and statistically analyzed.

It is worth noting that wheat is globally the second most widely grown cereal crop after rice. Statistics indicate that in 2014-2015 global wheat production was 707.2 million tons. In terms of quantity and area, wheat is the most popular cereal grown in the EU, constituting nearly half the total. However, wheat production in Europe is mainly affected by the occurrence of drought, late spring frosts and severe winter frosts associated with inadequate snow cover. In addition, overly wet and/or cool weather enhances disease occurrence, contributes to lodging and complicates crop management. This opens the way for the use of microbial biological control agents. Knowing the molecular mechanism that underlies the wheat response to *Trichoderma* strains/species inoculation could be useful in designing new generations of biological control agents. Such studies would be helpful for wheat-specific application of *Trichoderma* spp. for maximizing the benefits derived from this type of plant-microbe interactions. Therefore, it is anticipated that the results of this project will be interesting, not only for scientists, but also for agriculture and industry, and in particular manufacturers and suppliers of bio-pesticides, bio-fertilizers, growth enhancers and stimulants of natural resistance, and finally for cereal companies and consumers.